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SUNNYVALE COMMUNITY SOLAR ARRAY DEVELOPMENT

Feasibility Study

SILICON VALLEY INSTITUTE
for REGIONAL STUDIES

ACKNOWLEDGEMENTS

This Feasibility Study was prepared by Don Bray. It was developed under the framework and leadership of Joint Venture Silicon Valley's Smart Energy Enterprise Development Zone Initiative and the Silicon Valley Institute for Regional Studies, in association with the following study partners:

Optony Inc., a global research and consulting services firm focused on enabling government and commercial organizations to bridge the gap between solar energy goals and real-world results.

RevGen Consulting Group, which assesses industry trends and go-to-market strategies in such fields as renewable energy and the smart grid.

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Forward

Can multiple users share a solar array?

That is the question Sunnyvale's city leaders are asking, and for good reason: shared solar arrays reduce greenhouse gases, create economies of scale, and make it possible for new customers to access solar energy even though they can't deploy an array on their own property.

This report studies the feasibility and assesses the options for municipalities like Sunnyvale who want to provide residential and commercial subscribers with renewable energy. It follows on the heels of legislation signed into law in September 2013 (Senate Bill 43) which offers new regulatory mechanisms for deploying shared renewables projects in California communities. It also launched the Green Tariff Shared Renewables program (GTSR).

Though the implementation of the GTSR is still being determined in a rulemaking process led by the California Public Utilities Commission, Sunnyvale's leaders are prepped for action. This study provides the analytical foundation they require to evaluate new alternatives for community access. It reviews possible ownership structures, system design, related costs and revenues, and examines candidate locations. It was prepared by Don Bray at the Silicon Valley Institute for Regional Studies, in close consultation with RevGen Consulting Group and Optony, Inc.

The study will surely be of interest to other California cities contemplating shared renewable energy generation in their own communities.

Russell Hancock

President
Silicon Valley Institute for Regional Studies

Sunnyvale Community Solar Array Development Feasibility Study

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1. Executive Summary

Legislation now progressing through Sacramento may present new options for Shared Solar.

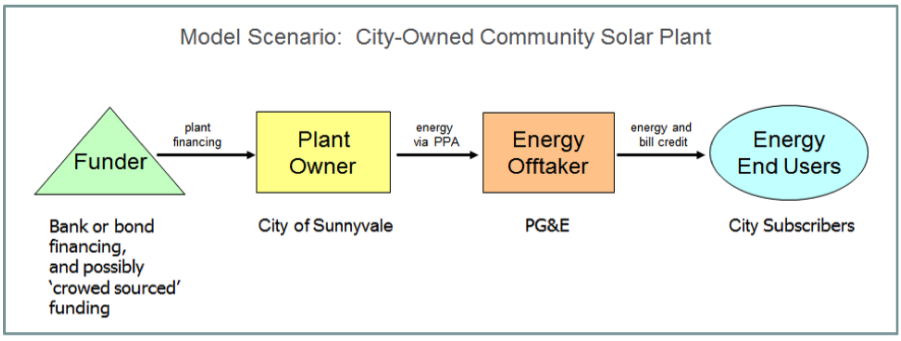
Early this year, the Sunnyvale City Council approved Council Study Issue DPW 13-11. This study issue examines the feasibility and benefits of constructing a large solar array and selling shares in the project to community members.

The feasibility of building a Community Solar array in Sunnyvale is a complex question, requiring analysis of regulatory, financial and physical site considerations. To date, the regulatory environment in California has not been favorable to Community Solar installation. Yet legislation now progressing through Sacramento may present new options for Shared Solar, making this a potentially opportune time for consideration of a Community Solar array in Sunnyvale.

Defining a Community Solar Array

To evaluate the regulatory and economic viability of a Community Solar array, it is necessary to further define assumptions for how such a system would be built, operated, and utilized. Figure 1 defines the 'Model Scenario' for a Sunnyvale-owned Community Solar plant, as requested in this Council Study Issue. Defining these specifics makes it possible to evaluate the critical elements of the scenario, and to define and analyze alternative options.

Fig. 1. Model Scenario: A City-Owned Community Solar Plant in Sunnyvale



In the model scenario, it is assumed that the Community Solar plant would be City-owned, and located on City property. The plant would be principally financed via bank or bond financing, and possibly partially financed using a 'crowd sourced' funding model (e.g. Mosaic) where individuals and organizations can buy shares in the project as a securitized investment, and receive interest

payments based on their invested principal. PG&E would be the energy offtaker, and in turn, would offer renewable energy produced by the array to residential and commercial customers under a designated renewable energy subscription program. Customers subscribing to this program would agree to pay a specified rate (tariff) for up to 100% renewable energy, to be applied against some or all of their energy use.

City Objectives and Priorities for a Community Solar Array

In this feasibility study, the primary interests of the City in establishing a Community Solar array were identified by City staff as reducing GHG emissions in the City, and providing access to solar power for residents and businesses that cannot currently utilize solar. Access to solar is a significant issue, as many residents and commercial energy customers occupy structures that are not suitable to deploying a solar array (e.g. roof configuration shading), or are limited by rental or lease arrangements.

Minimization of financial risk to the City was also identified as a high priority. A local array branded and controlled by the City of Sunnyvale was seen as desirable, but not mandatory. City ownership of the Community Solar array, while reflected in the model scenario, was deemed not required. To this effect, a third-party owned array on property leased from the City was established as an acceptable alternative for evaluation in the feasibility study. The objectives and relative priorities indicated above served as a basis for establishing, evaluating and comparing proposed Community Solar options and alternative Shared Solar programs as further described in Section 10. Current Challenges with Implementing a Community Solar Array

Currently, there are a number of critical challenges associated with implementing the model scenario and meeting all of the City's objectives. Understanding the basic nature of these challenges is important, as it informs development of 'structural options' for implementing a Community Solar array in the City. Key challenges with the model scenario include:

- Current regulatory policy in California does not allow the sale of energy from a centralized solar plant directly to end users in the community
- Except in the case where energy would be sold via an authorized Energy Service Provider (ESP) to commercial 'Direct Access' (DA) customers, energy from a Community Solar array would need to be sold to an IOU (PG&E) at negotiated terms competitively acceptable to the IOU
- Currently, there is no regulatory or operational mechanism whereby energy 'credits' from a Community Solar array could be applied to, or deducted from, a customer's energy bill
- PG&E is not currently (or likely in the future) to be obligated to sell energy or offer energy credits to City residents or businesses from power generated uniquely within Sunnyvale; PG&E would have to agree to voluntarily implement such a program
- If the solar array is City-owned as described in the model scenario, the City cannot take advantage of solar tax credit or accelerated depreciation benefits; these are very significant factors in making solar cost-effective.

Critical Pending Legislation

Importantly, there is a new deployment model for Shared Solar included in California Senate Bill 43 (SB43) that has passed both houses of the California state legislature, and is on the Governor's desk for signature as of this writing. SB43

potentially mitigates several of the regulatory challenges noted above, providing a mechanism for development of a Shared Solar array in the City our outside the City, and access to solar power for residential and commercial energy customers in the City.

Primary structural options for development of a Community Solar array within the City of Sunnyvale, presented later in this study, are dependent on the passage of SB43 or similar legislation.

Evaluating Sites for a Community Solar Array

It is recommended that the City of Sunnyvale consider the City Landfill Site or the Wastewater Treatment Plant Ponds for a Community Solar Array built within the City. These sites have sufficient contiguous area to install a reasonably large solar plant to service a large number of City commercial or residential end users, and limited potential for alternative uses. There are few unused sites in Sunnyvale that meet these basic criteria. At the landfill site, five adjacent areas comprising approximately 10 acres were identified by staff as most feasible for solar, on account of having the potential for the fewest competing uses or other environmental concerns. These 10 acres would support development of a solar plant with a rated capacity of approximately 3MW (megawatts). For purposes of comparison in this study, a plant of similar size and capacity was assumed for the wastewater treatment pond site although a larger solar plant could be installed on the pond. The City Landfill site has available space for such an installation. However, the southern portion of the site has a very high slope, roughly 30¡, which would require a custom racking system designed for the site. Movement in the ground layer can create offsets large enough to fracture the racking system, and damage the PV array. Additionally, in order to compensate for slope, the racking systems would need to be penetrated into the ground. These footing penetrations may be large enough to touch or damage the landfill cap layer.

Another concern is the financial viability of the landfill site, as the landfill is considered a "Park District". This may involve a significant financial charge for any land used for alternative purposes.

Alternatively, a 3MW (or larger) solar plant could be installed on the wastewater treatment plant pond site, using floating arrays, and utilizing a small percentage of the current total pond area. The solar plant could be located anywhere on the pond, where it makes the most sense from a technical and cost standpoint. Also, the array could be implemented incrementally, or expanded as capacity needs dictate. Similar floating installations have been successfully implemented in the US and elsewhere, with an example shown in figure 2.

Operational and design considerations that could affect the placement of the array on the wastewater treatment pond site include the need for minimal impact on the active operation of the current wastewater treatment plant, and on any

Figure 2. Sonoma County 200kW Floating Solar Array Example at Far Niente Winery.

re-design of the plant and ponds that is currently in-process. Elements such as shading could be an issue as algae production is relied upon for the oxidation process and benefits from evaporation. Also, anchoring of the array will need to be carefully considered, as the bottom of the wastewater treatment pond may not be suitable for anchoring or weighted moorings. An engineering study conducted in preparation for the release of a City RFQ for the community solar plant should address these design considerations.

Evaluation of 'Structural Options' for Implementing a Community Solar Array in Sunnyvale

Three primary structural options for deploying a Community Solar array in Sunnyvale were identified and evaluated, on the basis of the City's objectives and priorities. Emphasis was placed on minimizing City financial risk, serving the maximum number of potential City members, complying with current regulations, and the expected passage of SB43 legislation. The three primary options that were evaluated include:

- **Option A**
  The study's model scenario defined in Section 5, a City-owned Community Solar plant located in Sunnyvale, financed by the City, but with possible City investors; PG&E as the energy offtaker, and a solar power subscription available to residential and commercial customers in the City
- **Option B**
  Shareholder-owned Community Solar plant located in Sunnyvale, managed and operated by a third-party who also administers a shareholder ownership program; PG&E as the energy offtaker, and energy generated by the plant is credited to shareholders' energy bills based on share ownership (this billing approach would require a special agreement with PG&E)
- **Option C**
  A third party-owned Community Solar array located in Sunnyvale, financed, managed and operated by a third party; PG&E as the energy offtaker, and a solar power subscription available to residential and commercial customers in the City

Associated with each of these options are key characteristics and considerations, summarized in Table 1.

As scored in Table 2, Option C offers the greatest potential for meeting the City's Community Solar objectives. Use of a third party-owned plant minimizes the City's financial risk, enhances the likelihood of full funding for the plant, and offers the potential to serve all City business and residential constituents to the extent renewable energy is available under PG&E's Green Tariff Shared Renewables program. However, implementation is dependent on approval and implementation of SB43 legislation, and the negotiated sale of power to PG&E at a competitive price. Option B would likely be more difficult to implement, as many individual shareholders must commit to the project to ensure that a solar plant of sufficient capacity can be built. It also requires dedicated offtaker commitments (from PG&E) prior to scaled development. Approval and implementation of SB43 legislation may provide a framework for implementing this type of project structure, but additional negotiations with PG&E would be required to implement the bill credit mechanism and rate specific to this option. In addition, it may be difficult for solar energy produced under this option to be cost-competitive against third party-owned solar plants bidding under the RAM and Re-MAT programs discussed in Section 7.

Option A, the City-owned solar plant, has more limited potential for meeting the City's objectives. City ownership limits key tax benefits significantly impacting the cost of produced electricity. The City also assumes additional financial risk

Table 1. Summary of Primary Options and Key Characteristics

Option	Key Characteristics and Considerations
Option A: (Model Scenario) City-Owned Community Solar Plant	▪ Potential service to all city members ▪ City carries significant financial risk, can't utilize tax benefits ▪ May be difficult to find enough city subscribers to offset city investment ▪ Requires SB43 approval and implementation
Option B: Shareholder-Owned Community Solar Plant	▪ Potential service only to plant shareholders ▪ City has reduced financial risk, and can also be an investor in the solar plant without loss of tax benefits ▪ Some precedent for model in other states, but at relatively small scale (e.g. 500 KW to 1.2MW) ▪ SB43 approval required, and additional PG&E agreements likely necessary to implement
Option C: Third-Party Owned Community Solar Plant	▪ Potential service to all city members ▪ City has minimal financial risk ▪ Scalable, utility-based model ▪ Requires SB43 approval and implementation

Table 2. Analysis and Ranking of Primary Options

		Option		
Objective	**Priority**	**A**	**B**	**C**
Measured reduction in muni/community GHG inventory	5	◕	◑	●
Access to solar for underserved residential customers	5	●	●	●
Access to solar for space-constrained commercial customers	5	●	●	●
Manage/minimize financial risk to city	5	○	◕	◕
Community array located in city (economic impact, jobs)	4	●	◕	◑
Community array controlled/branded by the city	4	●	●	●
Positive financial return to city	4	○	◕	◕
Supported by existing regulatory structures (vs prospective)	4	○	○	○
Scalability, materiality and visibility e.g., impact and utilization	3	◑	◑	●
Positive financial return to customer/subscriber	3	◕	●	◑
Functional expandability supporting new/enhanced local grid service:	3	◕	◕	◕
Minimization of start-up costs and time to the city (e.g., planning, RF	3	○	◕	◕
Provide transferable subscription or share ownership	2	◕	●	◑
Community array owned by city (not third party lease)	1	●	○	○
Solar investment opportunity for residential/commercial constituents	1	◕	●	◑
weighted scores:		**170**	**183**	**199**

● = meets objective / significant potential contribution (5) ○ = does not meet objective / limited potential contribution (1)

associated with ownership and sale of electricity. As with Options B and C, implementation is dependent on approval and implementation of SB43 legislation, and the negotiated sale of power to PG&E at a competitive price.

Option C is considered the preferred choice over Option B, as it better meets the City's objectives at lower financial risk and with enhanced likelihood of scalability.

Three secondary options for Shared Solar were also presented in the study, but were not analyzed in further detail. The secondary options did not meet the full intent of the study request, but, in combination, could potentially provide another means for providing Shared Solar to constituents in the City. These options include a solar plant to serve local direct access customers or virtually net-metered municipal energy needs, or a remote solar plant to serve local residences and businesses.

Financial Analysis

Resource requirements and economics associated with the preferred choice, Option C, were analyzed and compared with the City's model scenario, Option A.

Based on the technical analysis and overall program goals, a 3MW-DC system was modeled for this analysis. Assuming a 180° azimuth and 30° tilt, a system with this capacity would produce approximately 4,680,000 kWh of energy in its first year of production. As shown in Table 3, Option A and Option C were modeled with the assumptions noted, and calculations made using industry standard tools and methods.

An annual solar array energy degradation factor of 0.5% is factored into the financial model. For Option C, an initial lease payment from the developer to the City of $2,500 per acre per year is assumed, and escalates at 3% per year.

The 20 Year System Levelized Cost of Energy (LCOE) for both options gives a good starting point for evaluating the costs and required pricing that the City (or a private developer) could charge its customers (including PG&E). LCOE is a measure used to compare the relative cost of energy produced by different energy-generating sources. LCOE is defined as the Total Life Cycle Cost divided by the Total Lifetime Energy production. These costs include estimates of all required project development, construction, maintenance and financing costs, assuming a construction completion date in 2016.

The system cost range reflects the variety of system designs, technology choices, construction techniques, financing methods and interconnection costs. For comparison purposes, current prices from existing wholesale and direct to PG&E

Table 3. Economic Analysis of Option C versus Option A

Assumptions	Option A	Option C
System Size	3,001	3,001
System Production (Yr. 1)	4,680,000	4,680,000
System Cost ($/W in 2016)	$2.25/W - $2.75/W	$2.25/W - $2.75/W
Installed System Cost Range	$6,750,000 - $8,250,000	$6,750,000 - $8,250,000
Tax Benefits	Not Applicable	30% ITC + 35% MACRS
O&M	$15/kW	$15/kW
Financing & Overhead Costs	10%	40%
Lease Payment	Not Applicable	$2,500 / Acre
20 Yr. System LCOE ($/kWh)	**$0.0993 - $0.1161**	**$0.0814 - $0.0982**

Reference Electricity Prices - Sales to Grid and Wholesale Buyers	
California Solar Feed-in-Tariff Contracts	$0.069 - $0.109/kWh
Price range impacted by location, in-service date, contract terms, client, technical design	

Financial Return to City	breakeven + risks	$670,000
Risks	Overhead, Performance, Subscribers	Vendor & Lease Management

End User Pricing (from PG&E) For Comparative Purposes (2013)		
	Part Peak/Off Peak	Peak
Current Residential Rates (Generation Only)	$0.057 - $0.100/kWh	$0.207/kWh
Current Commercial Rates (Generation Only)	$0.046 - $0.075/kWh	$0.120/kWh
TOU Schedule	*Nov-Apr, ALL Non-Workdays*	*May-Oct, Workdays Only*

feed-in-tariff contract are included. This represents the most likely range for "selling price" of the power that could be generated. Keeping in mind that these vary significantly based on the system size, location, timing and contract terms but are all potential price points that a Sunnyvale located solar array would need to "compete" against for sales of the produced power.

For further reference, the rate schedules for residential and commercial electricity customers of PG&E were evaluated and are presented in Table 3. While the utility purchases solar energy at the wholesale rates shown above, they then sell power at the retail rates based on time-of-use in the categories listed.

- Residential rates under schedule E-6-TOU, generating component only (this is all that could be offset under the Green Tariff Option.) Summer Peak includes only weekdays and no holidays during the months of May through October. Part peak and off peak times are within the months of November to April and all weekends and holidays throughout the year.
- Commercial rates under schedule E-19S-TOU generating component only (this is all that could be offset under the Green Tariff Option.) The same TOU schedule applies.

As seen in Table 3 above, the pro-forma costs for producing power under Options A and C are currently within the range of the wholesale contracts. Therefore, potential may exist over the next few years to cost-effectively develop these solar projects and provide net benefit to purchasers. However, it should be noted that other alternative energy sources are (or may become) available elsewhere that could aggressively compete with solar power development on the identified Sunnyvale sites. Under SB43, if passed, PG&E could consider supply contracts from solar as well as from other renewable sources (e.g. biogas, wind), and these sources could be located anywhere in PG&E's territory (though located as close to end users as feasible).

At the same time, it is important to assess what PG&E will potentially charge customers for renewable power it buys (from plants such as Sunnyvale's) under the new SB43 tariff – and to compare this with the current tariffs that residential and commercial customers are paying (as shown above). Current Time-of-Use generation pricing for residences are averaging between $0.10/kWh (partial peak) and $0.20/kWh (peak) hours of the day. The new SB43 tariffs will not be submitted to the CPUC until March 1st of next year, so it is difficult to anticipate exactly how they may be structured. However, if the new SB43 generation credit can be applied during the peak and part peak portions of the day, or if the credit is higher during these parts of the day, then price of power produced from the Sunnyvale solar plant under Option C could be comparable to or better than current residential peak power rates. Peak rate prices for commercial end users currently are closer to $0.12/kWh. As such, residential end users may be more likely to take advantage of the green tariff than commercial end users because of the greater potential savings on energy costs during peak hours. However, residential and commercial end-user adoption of this new tariff will be dependent on the actual rate schedule pricing approved by the CPUC, and outreach efforts to residents and businesses to encourage green power purchases.

Key Conclusions and Recommendations

If SB43 is signed into law, 'Green Tariff' rate schedules will be submitted by the IOUs and negotiated with the CPUC in the first half of 2014. PG&E's development capacity under this program would be in the range of ~250 MW between 2014 and 2018. As the size of this program is limited, it may be heavily subscribed, and time may be of the essence in developing solar plant proposals under this program.

In the near term, if the City wishes to further pursue the goal of establishing a Community or Shared Solar array within the City, the City should confirm the signing of SB43. If SB43 is signed into law, the City should consider the following course of action:

- Meet with PG&E to discuss the prospective solar development, utility expectations with respect to energy costs as supplied in a PPA with the City, and to confirm mutual interest in potentially supplying solar energy to PG&E under the new Shared Renewables program
- Elect to pursue a third-party development and ownership model (described in Option C), as this option ranks highest in terms of the City's objectives and priorities for a Community Solar Array
- Formally designate a prospective 'Community Clean Energy Park' on selected portions of the wastewater treatment pond and/or landfill sites for potential lease to a third-party developer, and to serve as a basis for further analysis and detailed proposal development for a community solar array
- Conduct an engineering study to develop a high-level system design, establish the technical scope and requirements for an RFQ process
- Solicit and evaluate RFQ responses from third-party solar developers to determine detailed economics (e.g. the rates at which power produced at the site could be sold to PG&E under the Green Tariff Shared Renewables program, or otherwise used by the City), and select preferred third-party developer.
- Actively track progress (and potentially influence) PG&E's submission of the 'Green Tariff' rate structure to the CPUC; this rate structure will need to be sufficiently attractive to energy customers in the City to motivate purchase of 100% renewable energy through the new utility program; if it is not, then customer uptake could be low, and benefits to the City minimal

- If the plant economics as established through the RFQ process are competitive, and if the Green Tariff rate structure as established by PG&E and the CPUC is acceptable, the City should authorize the third-party solar developer to formally propose the project to PG&E
- If the proposal is accepted, the City would authorize the selected third party to build plant, and actively encourage local residents and commercial customers to subscribe to PG&E's new Green Tariff, as GHG benefits will accrue directly to the City

If SB43 is not signed, the City's options for pursuing Community Solar at this time are extremely limited. In addition, if SB43 does pass, but the Utility's green tariff is deemed too high, or the PPA price for Sunnyvale-produced solar power is not competitive, then development of a Community Solar array will not be practical.

If SB43 is signed, but development of a solar array within the City's boundaries does not prove practical, the City could investigate working with a third party to contract for capacity at a remote solar facility as defined in the pending SB43 rulemaking, to serve Sunnyvale customers (residential and commercial), and/or actively promote customer subscription to PG&E's Green Tariff. These approaches have the potential to provide solar energy to all customers in the City (including underserved customers), at a competitive rate and on a large scale, and to significantly reduce GHG emissions within the City.

The City could also potentially pursue other Shared Solar approaches such as developing power for direct access customers or virtually net-metered municipal needs. Or, if in the future, the City ultimately moves to implement a Community Choice Aggregation program, or establishes a Municipal Utility, a local solar plant could potentially be developed to serve the City as a portion of the community's contracted energy mix.

2. Feasibility Study Background and Objectives

For a host of reasons, the feasibility of building a Community Solar array (CS) in Sunnyvale is a complex question.

In the State of California, the concept of Community Solar as requested in Study Issue DPW 13-11 is largely consistent with the solar industry description of this model, but cannot be generally implemented due to regulatory constraints. Yet the State Legislature may soon enable new mechanisms for enabling an alternative version of this type of deployment that can be called Shared Solar, but would not fit the definition of a "Community Solar array" as generally recognized by the solar industry.

In addition to regulatory questions, siting a Community Solar plant can be challenging from the perspective of physical suitability, as well as the potential for alternative uses of a given site. And to further complicate matters, the economics of solar power are very dynamic. While panel prices have fallen rapidly and reduced the cost to deploy solar, time-sensitive tax and incentive structures remain a key aspect in determining the economic viability of a given solar project.

In this feasibility study, Sunnyvale seeks input on the following key elements:

- Definition of key objectives and priorities for a Community Solar array in Sunnyvale

- Identification and analysis of primary 'structural options' for deploying Community Solar, including options for enabled by major legislation now pending in the state legislature; and identification of addition structural options for Shared Solar

- High-level assessment of the potential size and suitability of 1-3 selected Sunnyvale site(s) for deployment of a Community Solar array

- Evaluation of structural options for deployment of a Community Solar array at suitable site(s) in the City, in terms of legal or policy feasibility and constraints, high-level financial feasibility, physical feasibility, and other key Community Solar objectives and priorities

- Discussion on the feasibility, financing, phasing, and timeframes for design and implementation of both the Community Solar and Shared Solar development

- Discussion on the return on investment and cost comparison with Pacific Gas and Electric

Definitions

Because this topic is complex and there are many options and facets to consider while looking for viable solutions for the City, we will use the following terms in this document for clarity and consistency. The intent is to help readers to identify and understand the various major attributes of each option relative to the core City Council study issue:

Community Solar – this term will be used to describe the model that represents the key elements of the solar industry definition of Community Solar and is also the most consistent with the City Council's Study Issue. An authoritative resource on this model can be found here: www.nrel.gov/docs/fy11osti/50919.pdf.

Shared Solar – this term represents the broad spectrum of alternatives to the typical definition of Community Solar, but includes some key aspects of Community Solar, most importantly the ability to distribute solar power produced from a Solar Array to multiple electricity customers.

Solar Array – this term will be used to generically describe any solar power system, which may or may not include the attributes of Community Solar or Shared Solar.

3. Study Approach and Methods

An early step in this feasibility study was clear identification of Sunnyvale's objectives, priorities and scope for constructing a Community Solar array. Also, it was important to review the current regulatory landscape for Community Solar. Under current regulatory policy governing IOU (Investor-Owned Utility) territories in California, deployment of a Community Solar system exactly as conceived in the Study Issue is not permissible. Yet, concurrent with this feasibility study, there is a new 'green tariff' model which has been passed by the California state legislature. This has some of the characteristics of Community Solar, but would be more broadly defined as a Shared Solar program.

These questions were considered early in the study so that suitable 'structural options' for Community Solar in Sunnyvale could be established and evaluated. Accordingly, specific structural options for Community Solar in Sunnyvale were then assessed relative to the City's defined objectives and priorities, as well as key policy, regulatory, physical, and economic considerations.

In conducting this feasibility study, three workshop meetings were conducted with City staff during July and August 2013, to gather input, discuss key issues, and form project conclusions. Key workshop activities are delineated below:

- Definition, confirmation, and ranking of key objectives and priorities for Community Solar in Sunnyvale
- Identification and discussion of specific 'structural options' for deployment of a Community Solar array and the associated regulatory and policy landscape
- High-level assessment of the potential size and suitability of 1-3 selected Sunnyvale site(s) for deployment of a Community Solar array
- Assessment of potential energy cost economics for preferred option(s), including high-level comparison with PG&E rate structures where possible, and impact on City investment to implement
- Identification and discussion of estimated impact on City staff resources, and key City activities and responsibilities in deployment of a Community Solar array
- Identification and discussion of Shared Solar alternatives to a typical Community Solar system due to the current electricity regulatory environment.
- Identification and discussion of potential approaches such as grant funding, pilot projects, and private partner participation that could help reduce the City's required investment and/or implementation risk in deploying preferred option(s).
- Summarization of findings for inclusion in a final report, including discussion of current community renewables legislation, financial analysis of a community solar array including assumptions used in the analysis and potential implementation issues, candidate site(s), and overall recommendations for feasibility, phasing and general timeframes for design and implementation of preferred option(s).

4. Clarifying City Objectives and Priorities for Community Solar

Initially, the primary interests of the City in establishing a Community Solar array in Sunnyvale were identified as reducing GHG emissions in the City, and providing access to solar power for residents and businesses that cannot currently utilize solar. Access to solar is a significant issue, as many residents and commercial energy customers occupy structures that are not suitable to deploying a solar array (e.g. roof configuration shading), or are limited by rental or lease arrangements. Yet a number of other objectives were also important to understand and prioritize, including expectations for a financial return by the Cty and by end customers, assumption of financial risk, demands on City staff time, and future scalability of the array. To more broadly define the City's objectives and priorities for a community solar plant, the Sunnyvale team completed Table 4 below. Objectives were identified and listed, and then prioritized by the City team on a scale of 1 to 5, with a 5 indicating a 'must have' objective, and a 1 indicating an objective that was considered, but deemed not required.

The highest-priority objectives for the City were measured reduction in GHG inventory, access to solar to underserved residential and commercial customers, and minimization of financial risk to the City. A local array in Sunnyvale branded and controlled by the City was desired, but not mandatory. A City-owned community array, while reflected in the model scenario, was deemed not required. A third-party owned array on property leased from the City was established as an acceptable alternative for evaluation in the feasibility study.

The objectives and relative priorities indicated above serve as a basis for evaluating and comparing the proposed Community Solar options and alternative Shared Solar programs as further described in Section 10.

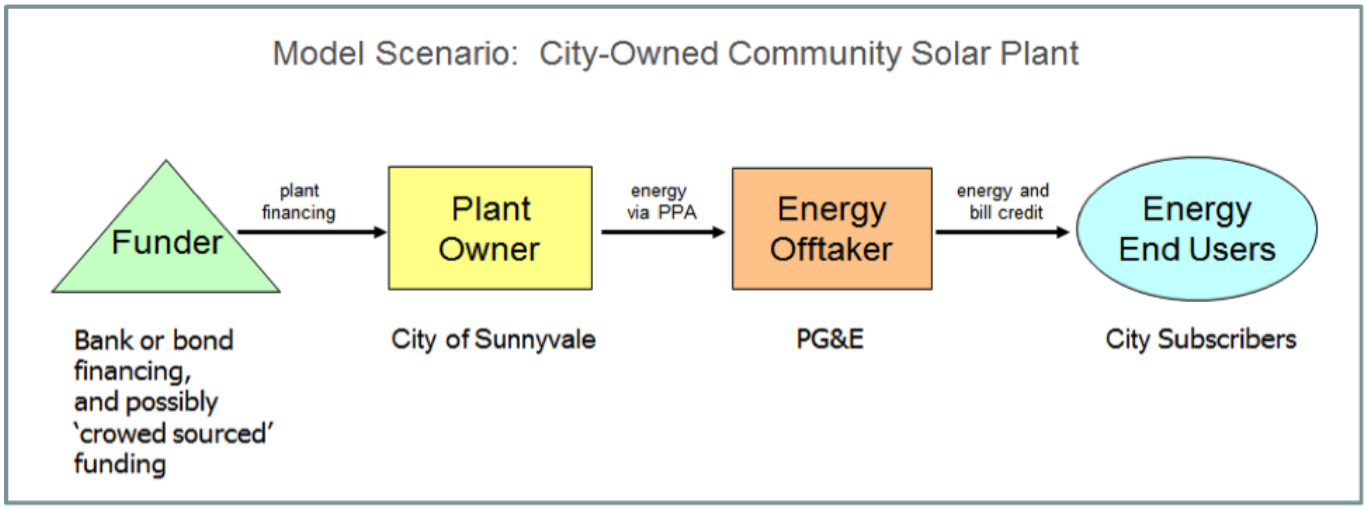
Table 4. Sunnyvale Objectives and Priorities for a Community Solar Array

Objectives . . .	must have 5	strongly desired 4	nice to have 3	if possible 2	not required 1
• community array owned by city (NOT third party lease)	○	○	○	○	●
• community array controlled/branded by the City	○	●	○	○	○
• community array located in city (economic impact, jobs)	○	●	○	○	○
• measured reduction in muni/community GHG inventory	●	○	○	○	○
• access to solar power for underserved residential customers	●	○	○	○	○
• access to solar power for space-constrained commercial customers	●	○	○	○	○
• solar investment opportunity for residential/commercial constituents	○	○	○	○	●
• provide transferable subscription or share ownership	○	○	○	●	○
• scalability, materiality and visibility e.g. impact and utilization	○	○	●	○	○
• positive financial return to customer/subscriber (lower energy costs)	○	○	●	○	○
• positive financial return to city	○	●	○	○	○
• manage/minimize financial risk to city	●	○	○	○	○
• supported by existing regulatory structures (vs. prospective)	○	●	○	○	○
• functional expandability supporting new/enhanced local grid services	○	○	●	○	○
• minimization of city start-up costs and time (e.g. planning, RFP)	○	○	●	○	○

5. Sunnyvale Community Solar "Model Scenario"

The 2013 Council Study Issue DPW-13 was established to examine the benefits to the City of building a 'Community Solar Array System'. To evaluate the regulatory and economic viability of a community solar array, it is necessary to further define assumptions for how such a system would be built and operated. Figure 3 defines the 'Model Scenario' for a City-owned Community Solar plant built in Sunnyvale, as conceived in this Council Study Issue. The model scenario describes critical assumptions for deployment, including funding, ownership, energy transmission and distribution (offtaking), and end use. Defining a Community Solar array in these terms makes it possible to effectively evaluate the critical elements of the scenario, and to define and analyze alternative options. In the model scenario, it is assumed that the Community Solar plant is to be located in the City of Sunnyvale, on City-owned property. The City owns the plant, and financing is provided through bank or bond financing. It would also be possible to finance a portion of the project using a 'crowd sourced' funding model (e.g. Mosaic) where individuals and organizations can buy shares in the project as a securitized investment, and receive interest payments based on their invested principal. In the model scenario, it is assumed that PG&E would be the energy offtaker. The City and PG&E would negotiate a PPA (Power Purchase Agreement), whereby the City would agree to sell the solar power produced by the solar plant to PG&E, for a specified price and duration.

Figure 3. Model Scenario: A City-Owned Community Solar Plant in Sunnyvale



In turn, PG&E would offer renewable energy produced by the array to residential and commercial customers under a designated renewable energy subscription program. Customers subscribing to this program would agree to pay a specified rate (tariff) for up to 100% renewable energy, to be applied against some or all of their energy use.

6. Key Challenges with the Model Scenario

Currently, there are a number of critical challenges associated with implementing the model scenario and meeting all of the City's objectives. Understanding the basic nature of these challenges is important, as it helps to inform development of other 'structural options' for implementing Community Solar and Shared Solar programs in the City, to be evaluated later in this report. Key challenges with the model scenario include:

- Current regulatory policy in California does not allow the sale of energy from a centralized solar plant directly to end users in the community
- Except in the case where energy would be sold via an authorized Energy Service Provider (ESP) to commercial 'Direct Access' (DA) customers, energy from a Community Solar array would need to be sold to an IOU (PG&E) at negotiated terms competitively acceptable to the IOU
- Currently, there is no regulatory or operational mechanism whereby energy 'credits' from a Community Solar array could be applied to, or deducted from, a customer's energy bill
- PG&E is not currently (or likely in the future) to be obligated to sell energy or offer energy credits to City residents or businesses from power generated uniquely within Sunnyvale; PG&E would have to agree to voluntarily implement such a program
- If the solar array is City owned as describe in the model scenario, the City cannot take advantage of solar tax credit or accelerated depreciation benefits; these are very significant factors in making solar cost-effective; additionally, the City would likely have to finance a significant portion of the solar plant initially via bank financing or bond measure

Importantly, as of the time of development of this feasibility study, there is a new deployment model for Shared Solar (although not the full Community Solar model) nearing enactment, under Senate Bill 43. SB43 potentially mitigates several of the challenges noted above, and providing a mechanism for development of a Shared Solar array in the City, and related access to solar power for residential and commercial energy customers in the community. Additional details of SB43 are described in Section 7. Also, Shared Solar mechanisms envisioned under SB43 (e.g. customer subscription, green tariff structure) that are relevant to development of a Community Solar array in Sunnyvale have been integrated into this feasibility study.

7. Pending Legislation for Shared and Community Renewables

Under current California legislation, there is no vehicle for providing energy from a Community Solar plant directly to end users, or permitting them to get a credit from an Investor Owned Utility (IOU) for energy purchased directly from a Community Solar array. The proposed California 'Green Tariff Shared Renewables Program' bill (SB43) potentially enables new 'structural options' for development of a Community Solar array in Sunnyvale, but would be more broadly considered as Shared Solar legislation.

The basic provisions of the bill are the following:

- The IOU (specifically PG&E for Sunnyvale implementation) arranges to purchase renewable (not just solar) power from third party renewable plants built anywhere within the IOU's region via long-term Power Purchase Agreements.

- The IOU and the third party providers recruit 'green power' subscribers, who then opt to purchase a certain percentage of renewable energy (up to 100% of the average generated power used in each month), and to receive a monthly bill credit for the amount of energy designated as renewable.

- The actual mechanism for determining the IOU's purchase price for the renewable energy, and determining the amount of credit to be received by each end user is not specified in the SB43 bill. The utilities will likely purchase the energy using mechanisms already in place such as the Reverse Auction Mechanism (RAM), or the Renewable Market Adjusting Tariff (Re-MAT) program authorized for California Feed-in-Tariffs. If used, these programs will establish the price paid by the IOUs for the renewable energy. The IOUs will add transmission and distribution costs and administrative costs to implement the new program in determining the new generation rates in $/kWh for the green energy tariff.

- The mechanism for establishing the green energy credit provided to subscribers will be proposed by each IOU in its tariff submittal to the CPUC which must be complete by March 1, 2014. The CPUC must approve or disapprove the proposed tariff by July 1, 2014. Guidelines in the legislation suggest that the credit calculation should reflect the following:

    - Sufficient credit to offset current class average retail generation rates

    - Adjustment for time-of-day usage

    - Credit to be applied against the generation part of the bill only (T&D and demand charges will be extra)

- The key implementation provisions of the bill are as follows:

    - Total program size of 600MW spread among the 3 major IOUs (PG&E's allocation will likely be about 260MW total)

    - Of the 600MW total, 100 MW must be set aside for top 'impacted areas' based on environmental and economic considerations

- Another 100MW of the 600MW must be set aside for residential usage
- No one community solar plant can be larger than 20MW
- No one participant can subscribe for more than 2MW, except schools and governmental entities which can subscribe for greater amounts
- IOUs must try to locate renewable facilities as close to the end users as feasible
- Each IOU must provide requesting cities an estimate of GHG reduction resulting from the green tariff credits issued to constituents of that City

The SB43 legislation has been approved by both the full Senate and Assembly and has been sent to the Governor for signature as of this writing. Indications are that approval by the Governor is likely.

Given the limited amount of capacity allocated to the PG&E region (approximately 250MW), it is possible that the program will be oversubscribed quickly. As such, if the City determines it is interested in pursuing development of a Shared Solar array in Sunnyvale, it would be in Sunnyvale's best interests to engage PG&E in early discussions.

8. Siting a Community or Shared Solar Array in Sunnyvale

For some municipalities (outside of California) that have pursued a Community Solar concept, actual siting of a large-scale solar array has been challenging. In addition to physical issues associated with a site's suitability for solar, social concerns can emerge among City constituents – including potential alternative uses for the site, or environmental impacts. The following factors will be important in ultimately selecting site(s) for a local solar array located in Sunnyvale:

- Sufficient contiguous area to install a reasonably large solar plant to service a large number of potential City commercial and residential end users (target at least 1 MW system)
- Ability to install south and south-westerly facing solar arrays without shading
- Relatively level location to simplify installation and reduce costs
- Ease of interconnection to local grid resources (generally systems of smaller size (e.g. <5 MW) are easier to interconnect from a utility grid standpoint)
- Little or no environmental or regulatory implementation challenges
- Limited competing use, opportunity cost, or near/intermediate-term development potential

There are few unused properties in Sunnyvale that meet the criteria defined in the above list. Based on a review of available land, the City is considering allocation of selected portions of the closed City Landfill site and/or Wastewater Treatment Pond site as potential solar array sites.

Analysis of Potential Sites in Sunnyvale

The City Landfill site has good solar potential, but there are constraints that limit the opportunity.

Figure 3 below indicates the landfill area along Caribbean Drive that could be made available for such a site. Site 1 in Figure 3 provides the most level land for the solar plant while Sites 2 through 5 provide land on a significant slope that could complicate the installation. If all five sites are utilized (roughly 10 acres), a solar plant with a rated capacity of approximately 3MW of solar could be installed, providing about 4,500 MWh of energy annually.

The landfill has available space for such an installation. However, there are a number of issues that would need to be considered in design:

- A penetration limitation of about 2 feet due to landfill cap will necessitate a ballasted installation; the additional concrete required for ballasting of the arrays will result in some additional cost and effort for the installation
- Although significant portions of Site 1 are relatively level, some leveling and dirt fill-in will probably be required that could add to the cost and effort required for installation
- Sites 2 through 5 have a considerable slope (roughly 30¡) will that add installation cost to properly align fixed-tilt arrays, especially given the restrictions on footing penetrations on the landfill; this would require a custom racking system designed for the site
- In the sloped areas, there are particular landfill settlement and depth of pier penetration concerns; landfill settling is a big concern for a ground mount system; movement in the ground layer can create offsets large enough to fracture the racking system, and damage the PV array; incremental costs for deploying solar on the sloped areas of the landfill due to geotechnical concerns could add 10-15% to the total installed costs, over and above the financial scenario shown in Table 9.
- Although the landfill area has not been used for several years, some settling could occur that could affect the alignment of the arrays over time; provisions would have to be incorporated to deal with this alignment issue
- Plant layout must accommodate access to gas venting areas, but this can be done during the initial engineering design
- The City has indicated that the landfill is considered park land with a high replacement value which could complicate its use for installation of a solar plant

Figure 4. Model Scenario: A City-Owned Community Solar Plant in Sunnyvale

The wastewater treatment ponds are located just north of the wastewater treatment plant. The City has over 440 acres of ponds that may be used for a floating solar PV system, which is more than enough for the 10 acres required for a 3MW-DC installation. The solar arrays would float on ponds and act as shade, while generating electricity. Typically these systems would use UV-resistant floating racking system with marine-grade submersible cables that would connect directly into a utility's transmission lines. This is a relatively new type of installation, and has become increasingly popular globally. This type of installation would address the limited available ground space to meet the desired 3MW community solar array.

A 3MW (or larger) solar plant could be installed while utilizing a small percentage of the total pond area. The site shown in Figure 4 is for illustration purposes only, and could be moved anywhere in the pond that made sense from a technical and cost standpoint. Also, the arrays could be implemented incrementally, or expanded as capacity needs dictate.

Figure 5. Sunnyvale Wastewater Treatment Ponds and Potential for Floating Solar Array

Similar installations have been successfully implemented in the US and elsewhere, with examples shown in Figures 5, 6 and 7.

Figure 6. Napa Valley Winery 1.2MW System Example

Figure 7. Sonoma County 200kW System Example for Far Niente Winery

Figure 8. Japanese 1MW System Example

The Sonoma County Water Agency (SCWA) is currently evaluating proposals for a 100kW solar array to be located either on one of its waste water treatment ponds, or on the banks of the pond. Since the procurement is ongoing, actual pricing for the project could not be disclosed. However, the project manager indicated that both approaches were very close in price from a $/W standpoint. SCWA is also considering a much larger procurement for a 3MW solar plant to be installed on one of its waste water ponds. This procurement would likely occur in the first half of 2014.

In 2011, the Santa Rosa Utility Department did a very thorough analysis of a 1MW floating solar array on one of the holding ponds of its treatment plant. The floating approach was one alternative considered in addition to a ground-mounted array Santa Rosa utilized both engineering and environmental consultants to assess the impact of the floating solar array on plant operation and the surrounding environment. The conclusion was that the floating solar array did not create any technical or environmental issues that could not be easily addressed during installation or ongoing maintenance. Based on bids received, the floating array installation was slightly higher on a $/W standpoint than a ground-mounted system, but the ongoing O$M costs were found to be lower so the Total Cost of Ownership was almost equivalent. Unfortunately, Santa Rosa ultimately decided not to pursue the solar array installation at all because of budget shortfalls.

Some of the considerations for installation of the solar plant on the wastewater treatment pond include the following:

The arrays would be installed on floating "pontoons" or equivalent platform and anchored to ensure that alignment with the sun is maintained in the presence of winds and waves. This issue can be easily addressed during initial engineering design.

Interconnection of arrays and cabling for grid interconnection would be installed underwater to high-grade marine specifications, but again this has been done successfully in prior installations.

The cabling run to the grid interconnect point could be somewhat longer since it has to be run from the floating arrays to a fixed point on the land. However, running the cables underwater help reduce the cable losses due to heat buildup, thereby offsetting some of the losses due to the longer cable run. The actual delivered power will be calculated as part of the initial engineering design.

The site for the floating array would have to be chosen to minimize any environmental or wildlife sanctuary considerations.

There are fewer suppliers for floating arrays, but several competent solar firms can do the installation; it is not expected that there would be a significant price difference for a floating installation versus installation on the level portion of the landfill; these costs are assumed in the economic analysis shown in Table 9.

Operational and design considerations that could affect the placement of the array on the wastewater treatment pond site include the need for minimal impact on the active operation of the current wastewater treatment plant, and on any re-design of the plant and ponds that is currently in-process. Elements such as shading could be an issue as algae production is relied upon for the oxidation process and benefit from evaporation. Also, anchoring of the array will need to be carefully considered, as the bottom of the wastewater treatment pond may not be suitable for anchoring or weighted moorings. An engineering study conducted in preparation for the release of a City RFQ for the community solar plant should address these design considerations.

9. Establishing 'Structural Options' for Community and Shared Solar

Several structural options were identified to meet the City's objectives as discussed in Section 6. The emphasis was placed on minimizing City financial risk, serving the maximum number of potential City members, and complying with current regulations, and the expected passage of SB43.

The three primary options that were evaluated were the following:

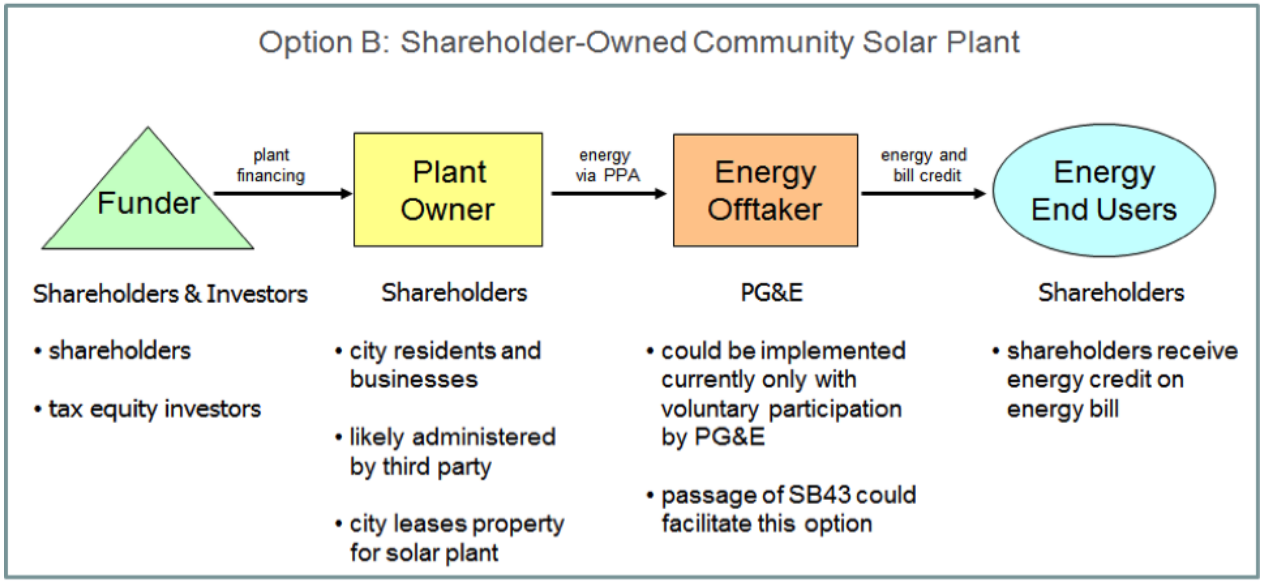
Option A The study's model scenario defined in Section 5, a City-owned Community Solar plant located in Sunnyvale, financed by the City, but with possible City investors; PG&E as the energy offtaker, and a solar power subscription available to residential and commercial customers in the City

Option B Shareholder-owned Community Solar plant located in Sunnyvale, managed and operated by a third-party who also administers a shareholder ownership program; PG&E as the energy offtaker and energy generated by the plant is credited to shareholders' energy bills based on share ownership (this billing approach would require a special agreement with PG&E)

Option C A third party-owned Community Solar array located in Sunnyvale, financed, managed and operated by a third party; PG&E as the energy offtaker, and a solar power subscription available to residential and commercial customers in the City

Option A, the model scenario, was described in Section 5. Option B is depicted graphically below, in Figure 8.

Figure 9. Option B: Shareholder-Owned Community Solar Plant



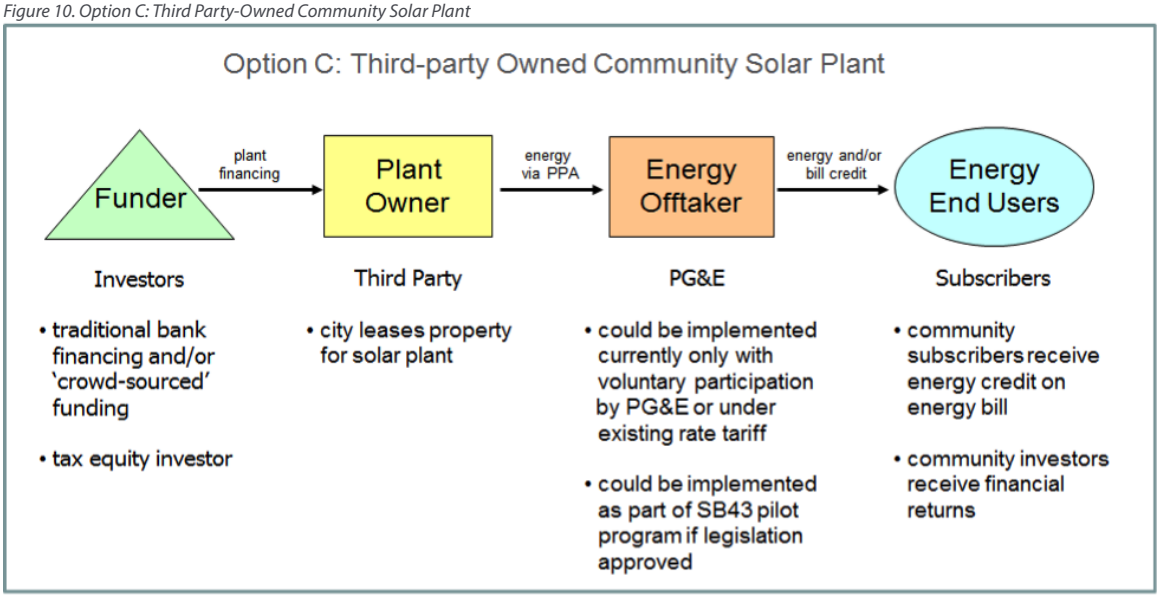
In Option B, a third-party arranges for all tax equity and individual shareholder financing for the plant, operates the solar plant, leases the land from the City, and sells the energy to PG&E. The shareholders actually own a set number of modules in the solar plant. The only recipients of the energy would be the plant shareholders. The third-party would administer the energy credit program for PG&E, and the energy credit on the monthly bill would be based on the number of modules owned by each shareholder. As implemented in other states in the US, the energy credit received from the utility exactly matches the price for which the energy is sold to the utility. This business model cannot be implemented under current California regulations.

Option B could be facilitated by the passage of SB43, but this process for energy procurement and customer credit potentially deviates from that envisioned in SB43. Exactly how procurement and bill credit will work will be determined in the CPUC rulemaking subsequent to SB43 passage. However, the Option B approach offers potential benefits for PG&E. A third party assumes responsibility for acquiring subscribers, the program is utility-branded but the bill credit process is administered by the third party, and the third party recruits replacement subscribers if the original module owners move out of the area.

Also, the City could potentially benefit directly from this approach by becoming an investor in the solar plant, as well as a subscriber for the energy credit. The business model is constructed such that no tax credits or depreciation benefits accrue to the solar module owners. This approach allows the City to avail itself of the investment benefit while also receiving an energy credit for the number of modules owned in the solar plant.

Option C is a third party-owned Community Solar plant. Figure 9 depicts this structure.

Figure 10. Option C: Third Party-Owned Community Solar Plant



Under Option C, a third-party arranges for all tax equity and other financing for the plant, owns all or a majority of the plant, operates the plant, leases the land from the City, and sells the energy to PG&E. Approval of SB43 legislation would be required for PG&E to credit the energy from the plant to Sunnyvale subscribers participating in the program. Table 5 compares the key characteristics of the three primary options.

Table 5. Summary of Primary Options and Key Characteristics

Option	Key Characteristics and Considerations
Option A: (Model Scenario) City-Owned Community Solar Plant	▪ Potential service to all city members ▪ City carries significant financial risk, can't utilize tax benefits ▪ May be difficult to find enough city subscribers to offset city investment ▪ Requires SB43 approval and implementation
Option B: Shareholder-Owned Community Solar Plant	▪ Potential service only to plant shareholders ▪ City has reduced financial risk, and can also be an investor in the solar plant without loss of tax benefits ▪ Some precedent for model in other states, but at relatively small scale (e.g. 500 KW to 1.2MW) ▪ SB43 approval required, and additional PG&E agreements likely necessary to implement
Option C: Third-Party Owned Community Solar Plant	▪ Potential service to all city members ▪ City has minimal financial risk ▪ Scalable, utility-based model ▪ Requires SB43 approval and implementation

Three secondary options were also evaluated that do not meet the full intent of the study request, but, in combination, could provide another means for providing Shared Solar to constituents in the City. These three options are:

- **Option D**
  Local solar plant that serves only Direct Access customers within Sunnyvale through an authorized Energy Service Provider
- **Option E**
  Local solar array that serves Sunnyvale municipal facilities through the Renewable Energy Self-Billing Credit Transfer (RES-BCT) program. The energy output from the plant would be virtually net metered to offset usage at other City facilities such as the administrative buildings on Olive Avenue and the Community Center.
- **Option F**
  Remotely-located third party-owned Shared Solar array that would sell energy to PG&E under the SB43 program. Sunnyvale customers subscribing to PG&E's Green Tariff program could utilize this energy and reduce GHG emissions in the City; also, this remote third party capacity could potentially be specifically developed and allocated to Sunnyvale subscribers, depending on the exactly how the rules for procurement and billing are determined in the SB43 rulemaking by the CPUC, subsequent to SB43 passage.

Table 6 summarizes the key characteristics of each secondary Shared Solar option.

Table 6. Summary of Secondary Shared Solar Options and Key Characteristics

Option	Key Characteristics and Considerations
Option D: Third-Party Owned Shared Solar Plant Serving Local 'Direct Access' Customers	▪ Serves only a small sector of city end users (e.g. commercial DA customers) ▪ City has minimal financial risk, modest financial return (lease) ▪ Can be implemented under current regulations
Option E: Third-Party Owned Shared Solar Plant Serving Municipal Facilities Under RES-BCT Program	▪ Serves only a small sector of city end users (e.g. city facilities) ▪ While the City would have limited financial risk, energy cost savings have been difficult to find under the RES-BCT program ▪ Can be implemented under current regulations, but PG&E is contemplating not accepting new applications
Option F: Remote Shared Solar Plant Serving Local Customers	▪ Serves all city end users, but from a plant located outside of Sunnyvale ▪ Program could potentially serve many Sunnyvale customers, and reduce the City's GHG inventory emissions ▪ City has no financial risk, but no financial or economic development return ▪ Requires SB43 approval and implementation

Each of the three secondary options, considered on a standalone basis, do not meet significant objectives of the Community Solar program but do provide Shared Solar resources to the community. Options D and E do not serve a large percentage of City members. Option F does not physically implement a local solar array in Sunnyvale. However, an approach whereby either Option D or Option E is used in conjunction with Option F could be a way of serving a large part of the community. A local plant would serve a limited number of City end users, and a remote plant would serve the rest of the community.

Since these three options do not directly meet the intent of the initial study request, they will not be considered in the option comparison in the next section.

10. Evaluating and Ranking Structural Options

Table 7 below compares Options A, B and C versus the City's prioritized objectives for a Community Solar array. For each objective, the three options were scored on how well they comply that objective. Fully darkened circles indicate complete compliance with the objective, and fully white circles represent very little compliance with the objective. Partial compliance is indicated by one-quarter, one-half or three-quarter shading of the circle. Then, based on the degree of compliance, a weighted score was assigned based on the City's priority for that objective. The highest priority objectives were weighted with a multiple of five, whereas the lowest-priority objectives were weighted with a multiple of one. The detailed rationale and scoring for each option is provided in Appendix A. The table below is a pictorial summary of the results. The total score for each option is also provided.

Table 7. Analysis and Ranking of Primary Options

Objective	Priority	Option A	Option B	Option C
Measured reduction in muni/community GHG inventory	5	◕	◑	●
Access to solar for underserved residential customers	5	●	●	●
Access to solar for space-constrained commercial customers	5	●	●	●
Manage/minimize financial risk to city	5	○	◔	◕
Community array located in city (economic impact, jobs)	4	●	◕	◑
Community array controlled/branded by the city	4	●	●	●
Positive financial return to city	4	○	◕	◕
Supported by existing regulatory structures (vs prospective)	4	○	○	○
Scalability, materiality and visibility e.g., impact and utilization	3	◑	◑	●
Positive financial return to customer/subscriber	3	◕	●	◑
Functional expandability supporting new/enhanced local grid service:	3	◕	◔	◕
Minimization of start-up costs and time to the city (e.g., planning, RF	3	○	◔	◔
Provide transferable subscription or share ownership	2	◔	●	◑
Community array owned by city (not third party lease)	1	●	○	○
Solar investment opportunity for residential/commercial constituents	1	◔	●	◑
weighted scores:		**170**	**183**	**199**

● = meets objective / significant potential contribution (5) ○ = does not meet objective / limited potential contribution (1)

Option C offers the greatest potential for meeting the City's Community Solar objectives. Use of a third party-owned plant minimizes the City's financial risk, enhances the likelihood of full funding for the plant, and offers the potential to serve all City business and residential constituents to the extent renewable energy is available under PG&E's Green Tariff Shared Renewables program. However, implementation is dependent on approval and implementation of SB43 legislation, and the negotiated sale of power to PG&E at a competitive price.

Option B is more difficult to implement because many individual shareholders must commit to the project to ensure that a solar plant of sufficient capacity can be built. It also requires dedicated offtaker commitments (from PG&E) prior to scaled development. Option B could be facilitated by the passage of SB43, but this process for energy procurement and customer credit deviates from that envisioned in SB43, and would need to be negotiated separately with PG&E. Also, it may be difficult for solar power provided under Option B to be cost-competitive against third party-owned solar plants bidding under the RAM and Re-MAT programs, discussed in Section 7.

Option A, the City-owned solar plant, has more limited potential for meeting the City's objectives. City ownership limits key tax benefits significantly impacting the cost of produced electricity. The City also assumes additional financial risk associated with ownership and sale of electricity. As with Options B and C, implementation is dependent on approval and implementation of SB43 legislation, and the negotiated sale of power to PG&E at a competitive price.

Option C is considered the preferred choice over Option B, as it better meets the City's objectives at lower financial risk and with enhanced likelihood of scalability. Resource requirements and economics associated with the preferred choice, Option C, are further analyzed and compared with the City's model scenario, Option A, in Section 11.

11. Further Analysis of Top-Ranked Structural Options

In addition to being evaluated against the City's prioritized objectives for a Community Solar array, Options C and A have been further evaluated to compare relative City activity requirements and economic performance. The following sections evaluate the resource and economic considerations associated with Options C and A.

City Activities and Responsibilities

Table 8 summarizes the tasks required to implement a Community Solar plant and compares the City's responsibilities for completing these tasks for Options A and C. Both options require identification of a suitable site, selection of the solar plant provider via RFP, and marketing and public outreach to recruit Community Solar subscribers. Option C also requires negotiation of a land lease agreement with the selected third party operator. A land lease is unnecessary if the City owns the solar plant as in Option A.

Table 8. Comparison of City Activities and Responsibilities

Task	Option A	Option C	Comments
Identify suitable site	X	X	Both options would likely will require third party technical feasibility study
Arrange for financing	X		No city tax credit or accelerated depreciation possible in Option A; could finance through tax equity partner
Obtain local shareholders	X		Could potentially utilize MOSAIC or similar third party 'crowd source' financing in Option A
Prepare RFP and evaluate, select and negotiate solar plant provider	X	X	Likely subcontracted to third party to run competition with city oversight
Prepare and negotiate land lease agreement		X	Done with third party in conjunction with PPA negotiation
Negotiate PPA with PG&E	X		Likely third party assistance in negotiating Option A PPA
Recruit utility customers to program	X	X	The City will likely need to encourage participation through outreach efforts
Prepare RFP and negotiate third party O&M contract	X		Could be plant provider or other third party in Option A

In contrast, Option A requires the City to perform several additional tasks that would not be required for Option C including:

- Funding the project through a bank or other financing institution and/or tax equity partner, or through a bond measure.
- Offsetting plant expense by selling shares to individual shareholders, likely through a crowd-sourced arrangement similar to that provided by MOSAIC or other third party.

- Negotiating the Power Purchase Agreement (PPA) with PG&E to establish the price of energy furnished, either directly or through a subcontracted third party.
- Competitively selecting, via RFP, a third party to operate and maintain the City-owned plant.

Option A will clearly require significantly greater allocation of City procurement, financial, and legal resources.

Economic Analysis

Based on the technical analysis and overall program goals, a 3MW-DC system was modeled for this analysis. Assuming a 180¡ azimuth and 30¡ tilt, a system with this capacity would produce approximately 4,680,000 kWh of energy in its first year of production. As shown in Table 9, Option A and Option C were modeled with the assumptions noted, and calculations were made using industry standard tools and methods. An annual solar energy degradation factor of 0.5% is factored into the financial model. For Option C, an initial lease payment from the developer to the City of $2,500 per acre per year is assumed, and then escalating at 3% per year.

The 20 Year System Levelized Cost of Energy (LCOE) for both options gives a good starting point for evaluating the costs and required pricing that the City (or a private developer) could charge its customers (including PG&E). LCOE is a measure used to compare the relative cost of energy produced by different energy-generating sources. LCOE is defined as the Total Life Cycle Cost divided by the Total Lifetime Energy production. These costs include estimates of all required project development, construction, maintenance and financing costs, assuming a construction completion date in 2016. The system cost range reflects the variety of system designs, technology choices, construction techniques, financing methods and interconnection costs. For comparison purposes, current prices from existing wholesale and direct to PG&E feed-in-tariff contract are included. This represents the most likely range for "selling price" of the power that could be generated. Keeping in mind that these vary significantly based on the system size, location, timing and contract terms but are all potential price points that a Sunnyvale located solar array would need to "compete" against for sales of the produced power.

Table 9. Economic Analyses

Assumptions	Option A	Option C
System Size	3,001	3,001
System Production (Yr. 1)	4,680,000	4,680,000
System Cost ($/W in 2016)	$2.25/W - $2.75/W	$2.25/W - $2.75/W
Installed System Cost Range	$6,750,000 - $8,250,000	$6,750,000 - $8,250,000
Tax Benefits	Not Applicable	30% ITC + 35% MACRS
O&M	$15/kW	$15/kW
Financing & Overhead Costs	10%	40%
Lease Payment	Not Applicable	$2,500 / Acre
20 Yr. System LCOE ($/kWh)	**$0.0993 - $0.1161**	**$0.0814 - $0.0982**

Reference Electricity Prices - Sales to Grid and Wholesale Buyers	
California Solar Feed-in-Tariff Contracts	$0.069 - $0.109/kWh
Price range impacted by location, in-service date, contract terms, client, technical design	

Financial Return to City	breakeven + risks	$670,000
Risks	Overhead, Performance, Subscribers	Vendor & Lease Management

End User Pricing (from PG&E) For Comparative Purposes (2013)		
	Part Peak/Off Peak	Peak
Current Residential Rates (Generation Only)	$0.057 - $0.100/kWh	$0.207/kWh
Current Commercial Rates (Generation Only)	$0.046 - $0.075/kWh	$0.120/kWh
TOU Schedule	*Nov-Apr, ALL Non-Workdays*	*May-Oct, Workdays Only*

For further reference, the rate schedules for residential and commercial electricity customers of PG&E were evaluated and are presented above. While the utility purchases solar energy at the wholesale rates shown above, they then sell power at the retail rates based on time-of-use in the categories listed.

- Residential rates under schedule E-6-TOU, generating component only (this is all that could be offset under the Green Tariff Option.) Summer Peak includes only weekdays and no holidays during the months of May through October. Part peak and off peak times are within the months of November to April and all weekends and holidays throughout the year.

- Commercial rates under schedule E-19S-TOU generating component only (this is all that could be offset under the Green Tariff Option.) The same TOU schedule applies.

As seen in Table 9, the pro-forma costs for producing power under Options A and C are currently within the range of the wholesale contracts. Therefore, potential may exist over the next few years to cost-effectively develop these solar projects and provide net benefit to purchasers. However, other alternative energy sources are (or may become) available that could aggressively compete with solar power development on the identified Sunnyvale sites. Under SB43, if signed, PG&E could consider supply contracts from solar as well as from other renewable sources (e.g. biogas, wind), and these sources could be located anywhere in PG&E's territory (though located as close to end users as feasible).

12. Charting a Path Forward: Designation of a 'Community Clean Power Park'

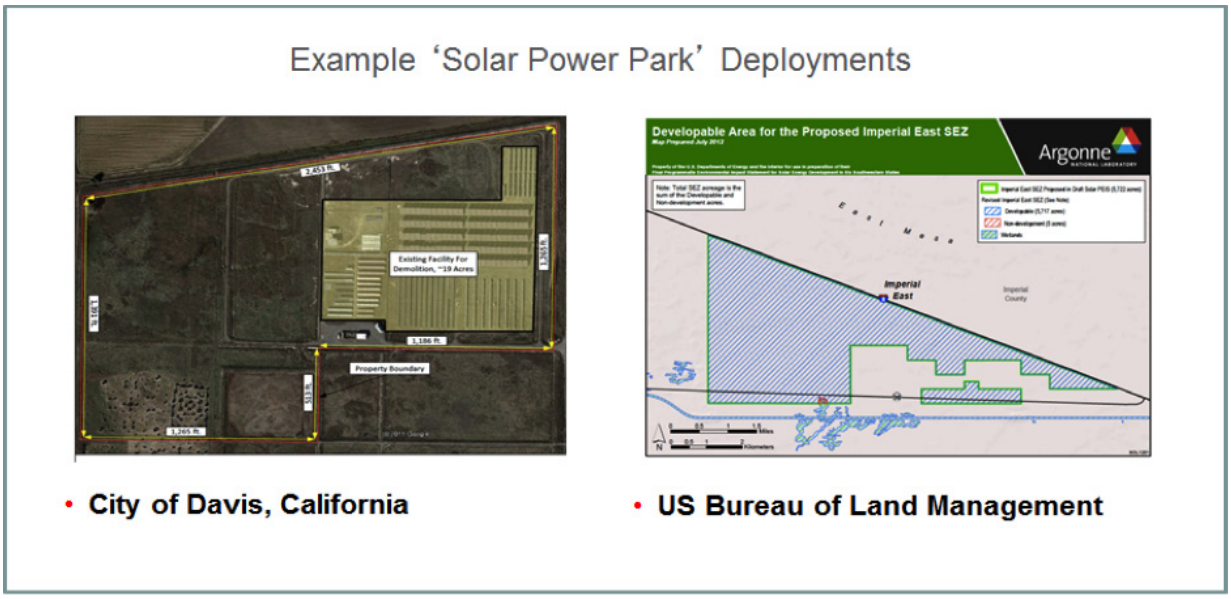
For communities considering establishment of a Community Solar deployment it is often difficult to know how to begin, how to 'phase' development activities, and how to effectively set and manage community expectations.

Critical first steps include communicating the concept, scope and intent of such an effort, and identification of specific geographic site(s) for potential deployment. These physical areas can be defined under the banner of a 'Solar Power Park' or similar name, providing an easy reference and association for further program development.

For instance, as shown in Figure 10, the City of Davis, California, is currently utilizing two major sites for third party development of solar power for "community benefit" (targeting aggregated net metering and direct access for municipal facilities.). And the Bureau of Land Management has established "Solar Energy Zone" project to facilitate expedited development of solar projects on BLM managed land in the southwest.

If Sunnyvale is interested in pursuing development of a Community Solar or Shared Solar Array within the City, the City should actively consider designation of selected City-owned property as a Sunnyvale 'Community Clean Power Park'. The term 'Clean Power' is broader and more inclusive than the term 'Solar'. Regulations such as SB43 for shared renewables are not limited to solar, and City maintains generation facilities using landfill gas and digester gas that potentially sell power to serve community purposes in the future.

Figure 11. Designated "Solar Power Zone" Examples



For the near-term purposes of building a Community or Shared Solar Array in Sunnyvale, establishment of a defined Community Clean Power Park would help to facilitate and expedite:

- Detailed solicitation of industry inputs (via RFQ) to identify and confirm latest, most economically beneficial way(s) to build a solar plant, and to establish and evaluate exact project economics
- Consideration and placement of site in PG&E development queue (potentially heavily subscribed) under pending SB43 green tariff shared renewables legislation
- Exploration of combination with other grid services (e.g., energy storage, EV charging) with potential for additional GHG reduction benefits, revenue generation and eligibility for grant funding

13. Conclusions and Recommendations

Development of a Community Solar Array within the City of Sunnyvale to serve local residential and commercial customers is not feasible under current regulatory policy governing IOU operations (e.g. PG&E territory) in California. While a Community Solar program would be possible under a Community Choice Aggregation or Municipal Utility construct, the only legal mechanisms whereby power can currently be provided from a Shared Solar array directly to direct access customers include only a very small number large commercial businesses (as described in Option 'D'), and/or possibly to the City itself, for use at various City locations on a 'virtual' net-metered basis (as described in Option 'E'). Neither of these scenarios meets the high priority objectives of the study issue – to make solar power broadly available to underserved residents or businesses that can't otherwise deploy solar. Yet new regulations supporting Shared Solar and key characteristics of Community Solar are likely to be implemented in the very near future. SB43 (the Green Tariff Shared Renewables Program) has been approved within the California State legislature, and is awaiting the Governor's signature.

In Sunnyvale, the Green Tariff Shared Renewables Program described in SB43 would be both supplied and operated by PG&E. There are two key elements to how this program will work:

- Firstly, PG&E would likely use a competitive procurement process to 'buy' solar power (or power sourced from other renewable assets such as wind or biofuels) in the form of power purchase agreements (PPAs) with local energy providers

- Secondly, PG&E will make this power available to residential or commercial customers who subscribe to the 'green tariff' program and agree to pay a pre-established rate for electricity that is generated from 100% renewable resources

If SB43 passes, 'Green Tariff' rate schedules will be submitted by the IOUs and negotiated with the CPUC in the first half of 2014. PG&E's development capacity under this program would be in the range of ~250 MW between 2014 and 2018. As the size of this program is limited, it may be heavily subscribed, and time may be of the essence in developing solar plant proposals under this program.

In the near term, if the City wishes to further pursue the goal of establishing a Community or Shared Solar array, the City should closely monitor the status of SB43. If SB43 is signed into law, the City should consider the following course of action:

- Meet with PG&E to discuss the prospective solar development, utility expectations with respect to energy costs as supplied in a PPA with the City, and to confirm mutual interest in potentially supplying solar energy to PG&E under the new Shared Renewables program

- Elect to pursue a third-party development and ownership model (described in Option C), as this option ranks highest in terms of the City's objectives and priorities for a Community Solar Array

- Formally designate a prospective 'Community Clean Energy Park' on selected portions of the wastewater treatment pond and/or landfill sites for potential lease to a third-party developer, and to serve as a basis for further analysis and detailed proposal development for a community solar array

- Conduct an engineering study to develop a high-level system design, establish the technical scope and requirements for an RFQ process

- Solicit and evaluate RFQ responses from third-party solar developers to determine detailed economics (e.g. the rates at which power produced at the site could be sold to PG&E under the Green Tariff Shared Renewables program, or otherwise used by the City) and select preferred third-party developer.

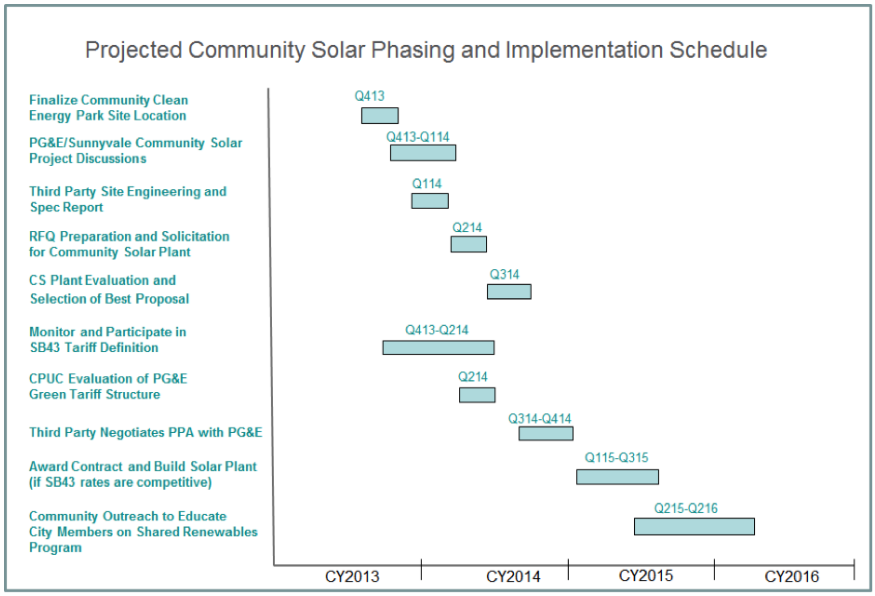
- Actively track, and potentially influence, PG&E's submission of the 'Green Tariff' rate structure to the CPUC; this rate structure will need to be sufficiently attractive to residential and commercial energy customers in the City to motivate purchase of 100% renewable energy through the new utility program; if it is not, then customer uptake of the program will be low, and the benefits to the City will be minimal

- If the plant economics as established through the RFQ process are competitive, and if the Green Tariff rate structure as established by PG&E and the CPUC is acceptable, the City should authorize the third-party solar developer to formally propose the project to PG&E

- If the proposal is accepted, the City would authorize the selected third party to build the solar plant, and actively encourage local residents and commercial customers to subscribe to PG&E's new Green Tariff, as GHG benefits will accrue directly to the City

Assuming passage of SB43, Figure 11 describes a general phasing and implementation scenario, including relative timing of the key activities noted above.

Figure 12. Projected Phasing and Implementation Schedule



If SB43 does not pass, the City's options for pursuing Community Solar are extremely limited. And if SB 43 does pass, but the Utility's green tariff is ultimately deemed too high, or the PPA price for Sunnyvale-produced solar power is not competitive, then development of a Community Solar array will not be practical.

If SB43 is signed, but development of a solar array within the City's boundaries does not prove practical, the City could investigate working with a third party to contract for capacity at a remote solar facility as defined in the pending SB43 rulemaking, to serve Sunnyvale customers (residential and commercial), and/or actively promote customer subscription to PG&E's Green Tariff. These approaches have the potential to provide solar energy to all customers in the City (including underserved customers), at a competitive rate and on a large scale, and to significantly reduce GHG emissions within the City. The City could also potentially pursue other Shared Solar approaches such as developing power for direct access customers or virtually net-metered municipal needs. Or, if in the future, the City ultimately moves to implement a Community Choice Aggregation program, or establishes a Municipal Utility, a local solar plant could potentially be developed to serve the City as a portion of the community's contracted energy mix.

Appendix A

	Community Solar Option Comparison			
OPTION A				
Objective	**Priority**	**Option A-City Owned (with Local Subscribers) Impact**	**Score**	**Opt. A Total**
Measured reduction in muni/community GHG inventory	5	should be medium-sized plant	4	20
Access to solar for underserved residential customers	5	all residences are potential subscribers	5	25
Access to solar for space-constrained commercial customers	5	all businesses are potential subscribers	5	25
Manage/minimize financial risk to city	5	highest financial risk for city	1	5
Community array located in city (economic impact, jobs)	4	located in Sunnyvale, can be specified to be built by local suppliers	5	20
Community array controlled/branded by the city	4	clearly city-wide initiative	5	20
Positive financial return to city	4	low ROI based on non-availability of tax writeoff for the city	1	4
Supported by existing regulatory structures (vs prospective)	4	must await implementation of SB43	1	4
Scalability, materiality and visibility e.g., impact and utilization	3	expansion difficult without new competitive RFP	3	9
Positive financial return to customer/subscriber	3	potential energy savings, possible ROI on investment	4	12
Functional expandability supporting new/enhanced local grid services	3	city could further reduce GHG emissions and possibly increase revenue	4	12
Minimization of start-up costs and time to the city (e.g., planning, RFP	3	competitive RFP and selection could be time consuming	1	3
Provide transferable subscription or share ownership	2	may be harder to transfer shares	2	4
Community array owned by city (not third party lease)	1	owned by city with local subscribers	5	5
Solar investment opportunity for residential/commercial constituents	1	may be difficult to find sufficient investors	2	2
				170
OPTION B				
Objective	**Priority**	**Option B-Shareholder-Owned Impact**	**Score**	**Opt. B Total**
Measured reduction in muni/community GHG inventory	5	number of shareholders could limit size of plant	3	15
Access to solar for underserved residential customers	5	all residences are potential subscribers	5	25
Access to solar for space-constrained commercial customers	5	all businesses are potential subscribers	5	25
Manage/minimize financial risk to city	5	higher chance of third party default	2	10
Community array located in city (economic impact, jobs)	4	located in Sunnyvale, third party could be influenced to use local suppliers	4	16
Community array controlled/branded by the city	4	clearly city-wide initiative	5	20
Positive financial return to city	4	third party absorbs ROI, land lease plus potential energy savings for the city	4	16
Supported by existing regulatory structures (vs prospective)	4	must await implementation of SB43	1	4
Scalability, materiality and visibility e.g., impact and utilization	3	expansion limited by size of available subscribers	3	9
Positive financial return to customer/subscriber	3	ROI on investment plus potential energy savings	5	15
Functional expandability supporting new/enhanced local grid services	3	could be difficult because it would require shareholder approval	2	6
Minimization of start-up costs and time to the city (e.g., planning, RFP	3	very little start-up cost, but must fit SB43 schedule	2	6
Provide transferable subscription or share ownership	2	built-in feature	5	10
Community array owned by city (not third party lease)	1	not owned by city	1	1
Solar investment opportunity for residential/commercial constituents	1	shareholder-owned model	5	5
				183
OPTION C				
Objective	**Priority**	**Option C-Third-Party Owned Impact**	**Score**	**Opt. C Total**
Measured reduction in muni/community GHG inventory	5	should be medium-sized plant, could be supplemented by remote plant	5	25
Access to solar for underserved residential customers	5	all residences are potential subscribers	5	25
Access to solar for space-constrained commercial customers	5	all businesses are potential subscribers	5	25
Manage/minimize financial risk to city	5	small chance of third party default	4	20
Community array located in city (economic impact, jobs)	4	located in Sunnyvale, third party may use out-of-area suppliers	3	12
Community array controlled/branded by the city	4	clearly city-wide initiative	5	20
Positive financial return to city	4	third party absorbs ROI, land lease plus potential energy savings for the city	4	16
Supported by existing regulatory structures (vs prospective)	4	must await implementation of SB43	1	4
Scalability, materiality and visibility e.g., impact and utilization	3	could be large plant	5	15
Positive financial return to customer/subscriber	3	potential energy savings, possible ROI on investment	3	9
Functional expandability supporting new/enhanced local grid services	3	third party should have financial objective to cooperate	4	12
Minimization of start-up costs and time to the city (e.g., planning, RFP	3	very little start-up cost, but must fit SB43 schedule	2	6
Provide transferable subscription or share ownership	2	transfer within SB43 guidelines	3	6
Community array owned by city (not third party lease)	1	not owned by city	1	1
Solar investment opportunity for residential/commercial constituents	1	could have many MOSAIC investors	3	3
				199

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